Research internship for Master 2 Nuclei, Atoms and Collisions

2018-2019

On the radiosensitising role of metallic nanoparticles: a study of the processes at the molecular level

Cancer hadrontherapy relies on the localised energy deposition at the Bragg peak in order to reduce the radiation effects on healthy tissues situated up- and downstream the tumor. However, due to the tumor size, several Bragg peaks (i.e. several beams with different energies) are superimposed to treat the whole tumor, subsequently losing a part of the benefit upstream. Radiosensitisers are used to locally enhance the energy deposition and the production of secondary particles like electrons and radicals. This could solve the energy deposition in upstream healthy tissues. New research focuses on the use of metallic nanoparticles as radiosensitisers.

In the framework of the European network FP7-ITN ARGENT (Advanced Radiotherapies GEnerated by Nanoprocesses and Technologies), we have developed an original new device allowing to produce in the gas phase a beam of metallic nanoparticles in order to study at the molecular scale the ion-nanoparticle interaction.

Up to now we have been able to produce in the gas phase different nanoparticles (size, metal) and we have studied their interaction with a low energy ion beam, corresponding to the Bragg peak "tail", produced at the GANIL facility. First results have shown that the ion-nanoparticle interaction is dominated in this energy regime by the sputtering of the nanoparticles producing atoms and small clusters of a few atoms which could increase toxicity and could explain the radiosensitising effect. This process was up to now not considered.

During the internship, the candidate will pave the way of further studies including the effect of the projectile (mass, charge, e.g. C^{q+} vs. O^{q+}) and of the nanoparticle (size, metal) on the sputtering. Another research axis will be carried out using a new detector allowing to measure the electron emission, the process considered so far in the models for radiation damage. Finally, the candidate could also address the effect of the "decoration" of the nanoparticle by chemical groups; such liganded nanoparticles are required in order to reach the cell.

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